U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-262 168-T

Distribution of Certain Rare-Earth and Nonferrous Metals in Coal Combustion

Environmental Protection Agency, Research Triangle Park, N C

Sep 76

BIBLIOGRAPHIC DATA SHEET	1. Report No. EPA TR76-712	2.	3. Recipient's Accession No.
4. Title and Subtitle DISTRIBUTION OF CERTAIN RARE-EARTH AND NONFERROUS METALS IN COAL COMBUSTION			5. Report Date 1968 6.
7. Author(s) I. Kh. Volodarskiy, I.T. Grekhov, V.I. Panin E.I. Shmuk, M. Ya. Shpirt			8. Performing Organization Rept. No.
9. Performing Organization Name and Address TRANSLATED FROM RUSSIAN BY EPA			10. Project/Task/Work Unit No. 11. Contract/Grant No.
12. Sponsoring Organization Name and Address Translation Service Office of Administration - Library Research Triangle Park, NC 27711			13. Type of Report & Period Covered 14.

15. Supplementary Notes
KHIMIYA TVERDOGO TOPLIVA No. 2 ,pp. 103-106, 1968.

16. Abstracts

17. Key Words and Document Analysis. 17a. Descriptors
EPAISD

17b. Identifiers/Open-Ended Terms
NON-RENEWABLE RESOURCES

REPRODUCED BY
NATIONAL TECHNICAL INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

17c. COSATI Field/Group 21D 97H, 97A,

18. Availability Statement THIS TRANSLATION WAS MADE FROM A NON-COPYRIGHTED TEXT.	19. Security Class (This Report) UNCLASSIFIED	21. No. of Pages 7
	20. Security Class (This Page UNCLASSIFIED	22. Price

362033

PB 262 168-T

TR 76-712

DISTRIBUTION OF CERTAIN RARE-EARTH AND NONFERROUS METALS IN COAL COMBUSTION
[Raspredelenie nekotorykh redkykh i tsvetnykh metallov pri szhiganii ugley]

by

I. Kh. Volodarskiy, I. T. Grekhov, V.I. Panin, E. I. Shmuk, M. Ya. Shpirt

Published in Khimiya tverdogo topliva [Chemistry of Solid Fuel], No. 2, pp. 103-106, 1968.

Many rare, scattered and nonferrous metals (gallium, molybdenum, tungsten, scandium, niobium, tantalum, lead and others) have been discovered in solid energy fuel (coals and shales) [1].

Currently, hundreds of millions of tons of energy fuel are mined which could become a serious potential raw material source of rare-earth and nonferrous metals even if their concentration in coal and shale is not high.

The bulk of energy coals and shales are used as fuel for power plants; moreover, their mineral components are divided between slag, which is separated out in the furnace chamber of water heaters, and the so-called ash soot, which is carried out of the furnace chamber by gaseous combustion products and to a certain degree is recoverable by the devices of the sanitation purification of flue gases. According to theoretical calcu-

Translated for NERC-Library, EPA, from the original Russian by LEO KANNER ASSOCIATES, P.O. Box 5187, Redwood City, California 94063, (415) 365-3046, September, 1976.

lations [2], the elements listed above are distributed in different ways between the slag and ash soot; some of them (lead, zinc, gallium and others) can be concentrated in the ash soot and thereby in the process of fuel combustion form gaseous compounds which condense as the combustion products cool on particles of ash soot; others (niobium, tantalum, scandium) do not form gaseous compounds and can either be distributed equally between the slag and the ash soot or be concentrated in the slag. As a result of these reasons, solid combustion products can be extremely enriched by a certain valuable component to a percentage where the ash soot can be considered a raw material for industrial extraction of this component. In particular, it has been established that minute fractions of ash soot are enriched with elements which form sublimating compounds.

The degree of enrichment of the slag or ash soot Y_{sl} or Y_{so} by a certain component can be computed by the following formulas:

$$Y_{sl} = \frac{b^i_{sl}}{K_{sl}}, \qquad (1)$$

$$Y_{so} = \frac{b^i_{so}}{100-K_{sl}}, \qquad (2)$$

where b^i_{sl} and b^i_{so} are the escape of the component into the slag or ash soot respectively, K_{sl} is the coefficient of slag recovery, the quantity showing the distribution of the macrocomponents of the mineral portion of the fuel between the slag and the ash soot

$$K_{sl} = \frac{a_{sl}}{a_3} \cdot 100,$$

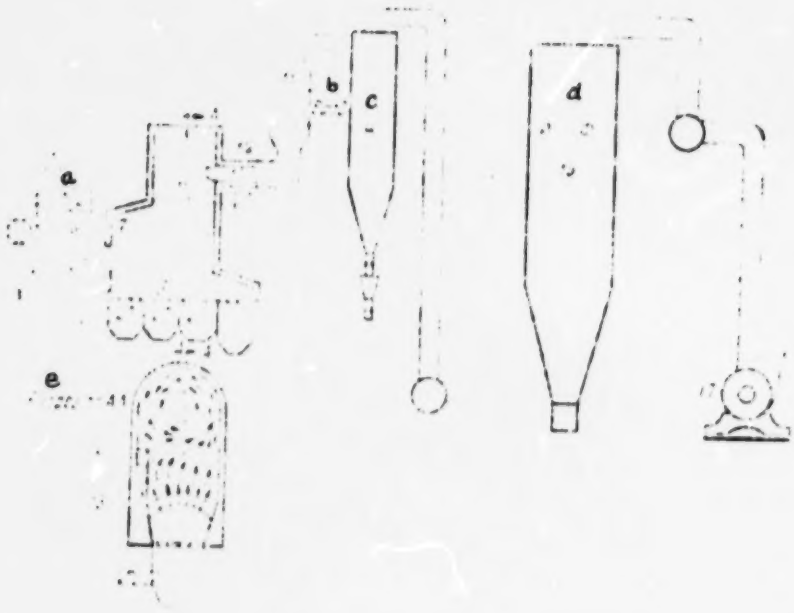
where a_3 and a_{sl} is the amount of ashes contained in 1 T of fuel and passing

from it into the slag respectively.

The coefficient of slag recovery does not depend on the percentage of rare-earth, scattered and nonferrous metals which are microcomponents of the mineral portion of the fuel,and is determined as a result of thermotechnical tests. For the currently most common coal-dust box furnaces K_{sl} fluctuates from 5 to 30%. Therefore, during coal combustion in these furnaces the degree of enrichment of the ash soot (Y_{so}) will not exceed 1.4 even with the maximum b^i_{so} = 100%. Consequently, it is expedient in these furnaces to burn coal containing valuable components which are highly nonvolatile and which primarily pass into the slag (with b^i_{sl}=100%, Y_{sl}= 20-3.3). However, judging by the current data, the content of highly nonvolatile elements in coal is lower than that of highly volatile elements and therefore, the utilization of the latter in coal combustion is of great practical importance. It is apparent that the easily volatile elements will primarily pass into the ash soot and in order to reach a higher quantity of Y_{so} it is necessary to burn coal containing similar elements in furnaces with the maximum K_{sl}. From this point of view the use of grate-fired and flame grate-fired furnaces in which $K_{sl} \geqslant 90\%$ can be reached and, consequently, $Y_{so} \geqslant 10$ (with b^i_{so}=100%),is important. In real conditions, the degree of transfer of a certain element into the slag or soot is not equal to 100%.

This report cites results of an experimental study on the distribution of rare-earth and nonferrcus metals in coal combustion in grate-fired (flame grate-fired) furnaces. Combustion occurred in the apparatus presented in the illustration.

Fuel from fuel bunker 1 enters screw feeder 2; from here it passes to



Schematic diagram of thermal testing unit equipped with a flame grate-fired furnace with vortical ash trap and apparatus for complete gas purification.
Key: a. SF (screw feeder)
b. intake
c. C (cyclone)
d. BF (bag filter)
e. Section at AA

pneumatic stoker 3. The fuel is stoked to fire grate 4 by an air jet coming from nozzle 5. Large particles of coal burn in the bed while the finer particles burn inside the furnace. Rabbling plate 6 disposes of the burnt slag into the slag bin and removes irregularities in the stoking of the fuel.

The grate is made of heat-resistant steel. It is 120 mm wide and the active zone is 250 mm long. The area of the active portion of the grate is 0.033 m^2. The fire grate is divided into three blasting zones.

The furnace is covered with a large anterior crown 7 and a small posterior crown 8. The geometrical dimensions and ratios between individual parts of the furnace chamber are similar to those of an industrial furnace.

Air is fed from a HPA-9 (high pressure air) fan 9 under the grate and to the pneumatic stoker. The so-called vortical ash trap is located in the upper portion of the furnace chamber which is made in the form of a semi-cylinder. The diameter of the chamber is 300 mm, its length is 280 mm and the diameter of the outlet structure is 10-100 mm. A secondary blast inlet to create a vortical flow has been made from the left side of the furnace. The secondary inlet enters through rectangular lateral nozzles 11, 22 x 4 mm in size.

Secondary air with a pressure of up to 500 mm water gage is fed from the HPA-9 fan. Between the secondary blast duct12 and the furnace wall there is a trap for separated particles which are discharged into the layer of burning fuel through a ½" pipe 13.

Furnace gases and particles not trapped in the furnace pass through gas flue 14 and feed-water economizer 15 in order to cool them and into the cyclone ash trap which is 300 mm in diameter. After the cyclone, the gases are sent to the two-section bag filter 16 where their final purification takes place. The bags are made of nitron.

After the bag filter the gases enter the exhaust fan. A HPA-8 fan which creates a discharge of up to 450 mm water gage is used as an exhaust fan.

A change in the amount of fuel supplied is implemented by a speed variator which permits the regulation of the number of revolutions made by the screw feeder within broad limits. The thermal testing unit is equipped with the necessary measuring apparatus and instruments for conducting balance and special tests.

Ashes are discharged from the cyclone and bag filter at the end of the

experiment.

Lignite with the following characteristics was taken for the experiments: W^P=28-31; A^C=18-20%. Previously prepared solutions of rare-earth and nonferrous elements (Y, V, W, Mo, Pb, Zn, Li) were applied to this coal. The solutions were prepared so that the concentration of all these elements in the ash was 150-180 g/T.

Yttrium oxide, vanadate of ammonium and molybdate of ammonium, lithium carbonate, sodium tungstate, lead acetate and mossy zinc were taken as initial reagents for application to the coal. Yttrium oxide, lead acetate lithium carbonate and mossy zinc were dissolved in sulfuric acid and the other substances were dissolved in water. Previously prepared samples of coal were soaked in the resulting solutions before burning.

In each experiment, 40-50 kg of coal were burned and the average input rate was 30 kg/hour. Consumption of primary air was 240 and 300m^3/h and the consumption of secondary air in all the experiments was constantly 140 m^3/h. In each experiment samples were taken of the initial coal, slag and soot trapped by the cyclone and bag filter.

In order to balance the distribution of the elements under study the solid products of combustion (slag, soot from the cyclone and bag filter) were analyzed by the colorimetric method for molybdenum [3]. Yttrium, vanadium, tungsten, lithium, lead and zinc were analyzed by the semi-quantitative spectral method.

The data on the distribution of molybdenum indicate that in the examined process 69-72% of the molybdenum passes into the ash soot. The degree of enrichment of the ash soot with molybdenum is roughly sevenfold. Yttrium, vanadium and lithium were only found in the slag. Consequently,

these elements are not sublimated in the process of combustion but are concentrated in the slag. Slags can become concentrates of these elements following combustion of coal containing yttrium, vanadium and lithium in chamber furnaces with the minimum coefficient of slag recovery (pulverized fuel furnaces with dry slag disposal).

Zinc and lead were noticeably concentrated in the ash soot, but in order to obtain definitive conclusions on their degree of concentration it is necessary to conduct additional experiments. The tungsten content was roughly the same in the slag and ash soot.

Conclusions

1. A study was made on the behavior of molybdenum, zinc, lead, tungsten, yttrium, vanadium and lithium during flame grate-fired combustion of coal in a testing apparatus.

2. During flame grate-fired coal combustion, lead, zinc and molybdenum primarily pass into ash soot while yttrium and vanadium pass into slag.

References

1. Albernethy, R. F. and F. H. Gibson, Inform. Circ., Bur. Mines, U.S. Dept. Interior, (No. 8163), (1963).

2. Volodarskiy, I. Kh., et al., Sb. Obogashchenie uglya i khimicheskaya pererabotka topliv., Proc. of Inst. of Min. Fuels, 23 (1), p.64 (1966).

3. Faynberg, S. Yu., Analiz rud tsvetnykh metallov [Analysis of Nonferrous Metal Ores], Metallurgizdat, 1953.